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Second Consultation on the Capital Goods Industry
with Special Emphasis on Energy-related Technology
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Issue Paper I

CONDITIONS OF ENTRY INTO THE CAPITAL GOODS SECTOR AND STRATEGIES FOR INTEGRATED MANUFACTURE *

Prepared by the

UNIDO secretariat

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1. The development of the capital goods industry is a long-term undertaking and involves mastering a wide range of technologies. This sector is the hard core of industrialization and permits the country to develop its own innovative genius rather than depend on imitating and copying others. The development of the capital goods industry in the developing countries is, probably, the only means with which the present imbalance in the international division of labour can be corrected. It is a fact that the majority of developing countries has no or only an embryonic capital goods industry. Therefore, the technological gap which exists between developed and developing countries can only widen in the future unless all of the parties involved, such as developing countries, technology owners, bilateral and multilateral funding agencies, and international financing and technical assistance organizations are prepared to mobilize an unprecedented effort. This statement is particularly true when the immense technological developments and industrial restructuring of the 1980s are considered.

2. The development of the capital goods industry is influenced by the rapid diffusion of highly sophisticated technologies mainly based on microelectronics and informatics. These technologies not only tend to save labour, but also to provide other substantial benefits to innovating enterprises. If this diffusion goes faster in industrialized than in developing countries, then the existing technological gap will widen, in which case, the anticipated industrial share of developing countries in capital goods production is likely to be even smaller than current perspectives suggest.

3. In some sectors the developing countries enjoy a comparative advantage which is chiefly based on less expensive labour. The new technological developments, however, may erode this labour-based comparative advantage, even in sectors like leather and textiles, because the industrialized countries will increase their productivity through rationalization of costs. It is of crucial importance for developing countries to evaluate the extent to which their comparative advantage vis-a-vis industrialized countries might be eroded in this way. A substantial erosion might, in the long-term, compromise the very industrialization efforts pursued so far.

4. To illustrate the point further, one could look at the CAD (computer aided design) systems with regard to the differences between the industrialized and developing countries. According to an UNCTAD report, the developing countries have only about 0.5 percent of the world's 6,000 CAD systems, and most of them are used for mapping and thus not in the engineering sector. In a recent UNIDO study three significant potential implications for developing countries were pointed out in this connection. First, although there are some signs of the use of CAD technologies in developing countries their diffusion is constrained by the absence of synergistic uses. Second, the global utilization of CAD technologies tends to concentrate precisely in those sectors where the developing countries made industrial progress in the 1970s. Accordingly, developing countries may face mounting competitive disadvantages which may threaten continued industrial growth. Third, the changing skill composition entailed in the introduction of CAD will present important advantages and disadvantages for developing countries.

5. The factors underlying previous redeployment of some industrial sectors to developing countries now seem to be affected by the increased automation of production processes in industrialized countries. On the one hand, the introduction of labour saving technologies in industrialized countries has increased the pressure for protectionist barriers, beginning in the most labour-intensive sectors (e.g., garments) and now spreading to other consumer (e.g., cars and television) and intermediate goods (e.g., steel). On the other hand, the downstream use of microelectronics in other sectors has begun to undermine the comparative advantage of developing countries producing with traditional technology and low-wage labour. Examples of such trends are the automated insertion of electronic components onto printed circuit boards, the packaging of the circuits themselves, the reduction of the number of circuits in many products, etc.

6. It seems therefore, that the redeployment process which has been a major element in speeding up the industrialization of developing countries is undergoing drastic changes. The increasing application of high-technologies in industrialized countries will accelerate this process. The developing countries must find adequate responses to the changing conditions above all in the development of their capital goods industry.

7. The large number of countries without a capital goods industry and the experiences of those which have already entered into the sector indicate that the most difficult stage toward the development of this sector is the "entry". The first question to answer, therefore, is: "Why have so many developing countries not yet entered into the capital goods sector?"

8. Thus, a systematic approach to the entry issue should start with seeking an answer to the fundamental question above. Once the specific answer relevant to each individual country is found then the plans can be drawn and policies and strategies can be formulated to remove the barriers to entry.

9. The particularly poor performance of developing countries in the capital goods sector is not without reason. A set of barriers hinders their industrialization in general, and development of capital goods sectors in particular. Although the type of barriers may change from country to country, there are always some of them present which have a negative impact on the development. It is, therefore, necessary to try to analyze these constraints.

10. One group of major barriers is what might be described as perceptual. The existence of such constraints can be felt from the following:

a) There appears to be a prejudice in favour of capital goods purchased from the suppliers in industrialized countries. This prejudice can be expressed in several ways ranging from quality and testing requirements to financing of purchases. It should also be noted that this barrier not only hinders the development of national capital goods industries, but also obstructs the promotion of trade between developing countries.

b) There is an unnecessary mystification of capital goods and their manufacture. The very large number and widely varying technological complexity levels of products and manufacturing processes are the main reasons of this mystification, and it frequently results in either abandonment of the idea of local manufacture or transfer of unsuitable and/or unnecessary technologies.

11. Eliminating one cynical explanation, one may argue that the first perceptual constraint is due to a combination of habit, training, and lack of technical and technological know-how. Habit, because a supplier has always been the supplier and there is a desire not to try to understand or develop new product specification. Training, because in many countries it is very

probable that the high level technical personnel in charge of product specification and purchasing have been trained in one of the developed countries. The result is that they have learned how to select equipment along specific lines. They adopt the same standards and use the same information as the manufacturers of the countries in which they did their training.

12. Sometimes more influential than habit or training is the lack of technical and technological know-how. Because of this deficiency, the purchaser prefers to accept the specifications of the established firms rather than to control the quality and carry out testing of the domestic products. The situation is aggravated when testing and quality control installations are not available in country. It is interesting to note that such installations can never be created if the domestic production does not exist.

13. Mystification of capital goods and their manufacture is probably the most dangerous and pessimistic approach. UNIDO identified this constraint while preparing for the First Consultation and several studies were carried out to bring some transparency to it. Among others, the methodology of Analysis of Technological Complexity (ATC) was devised to decipher the conditions of manufacture of diffferent capital goods. The analytical results and field

applications have revealed that there is scope for almost every developing country to start and sustain a capital goods industry provided that products and technologies are properly selected and every effort is made to remove those barriers which apply to each specific case.

14. Compared to all other industrial sectors, the need for skilled manpower is the highest in the case of the capital goods industry. Training of skilled and semi-skilled manpower takes time. Short-term solutions are not possible even if the financial resources and legislative framework are available. At the macro level, technical and managerial skills which support the industry in general, and the capital goods sector in particular, form the core of what might be called an "industrial tradition". The presence of industrial tradition also creates an attitude towards manufacturing. Skills at the macro level are normally formed through the organized educational process.

15. Micro level skills are required for the establishment of specific industries and/or plants. Training of such personnel goes far beyond formal education. There is much on-the-job training of engineers and production labour. The skills that are developed and passed on in on-the-job or plant-specific training constitute a large fraction of the technology mastered by the manufacturing company. Formation of the micro level skills is the hardest task for a developing country desiring to transfer and master technologies.

16. Lack of capital is another major constraint. But in many instances, its effect is magnified because of wrong allocation policies of Governments and/or bilateral and multilateral financing agencies. Allocation of scarce capital for which all sectors of economy compete heavily is one of the major issues. On the domestic side, the Government should have clear policies to allocate public funds among sectors and/or to formulate incentives to attract private capital to the capital goods industry. In the case of foreign currency allocations, it should be remembered that capital goods manufacturing requires funds not only for investment but also for production.

17. Market size which is usually discussed together with the economies of scale concept, is regarded as a major barrier to the development of the

capital goods industry in developing countries. This barrier alone, in the strict economical sense, can hinder the development of a capital goods industry in many developing countries. However, there are possibilities to reduce the effect of market constraint, provided that one stays within reasonable limits. For example, government interventions in the form of incentives to the supplier and/or support to the purchaser can easily change the level of economic scale of production (not the critical technological size). Furthermore, most of the technologically less complex capital goods can be produced by using conventional, general purpose machines and processes, making the multipurpose utilization of manufacturing facilities possible. This route enables the combination of individually insufficient markets of different products into an economically viable size.

18. Fluctuations of domestic demand is probably more important than average market size itself. No capital goods industry can exist in an environment of dramatic peaks and troughs. To reduce the probability of fluctuations occuring, careful planning and consistent long-term policies and strategies are needed. As a precaution, furthermore, the manufacturing facilities could be designed to be flexible enough to change their product mix in order to cope with future market fluctuations. This, however, is not always easy to implement.

19. As the technological complexity of capital goods increases, the use of special and/or dedicated production machinery and processes becomes necessary. Market size, then, should draw more attention. For these capital goods, the size of an internal market plays a major role in defining the level of sectoral development. If the domestic market size is insufficient or there is a comparative advantage, then development of an international market should be considered. This can be done in two ways, either through active export promotion in a free market environment or through some forms of trade in common market structures. Creation of common markets is a potential area for regional co-operation among developing countries. This theoretically attractive alternative appears not to be politically and/or administratively feasible under most circumstances. It can be argued, however, that this is the only way in which some of the developing countries will ever be able to develop their capital goods industry.

20. In some instances, product and technology choices of a developing country are made under the influence of bilateral and/or multilateral funding agencies. This practice does not only weaken the negotiating position of the developing country but may also end up transferring unsuitable designs and technologies.

21. Access to technology also appears to be a constraint, especially when high technologies are sought for transfer. This barrier, theoretically, does not exist at the low technology end. However, its impact is also felt there due to inability of small- and medium-scale enterprises to reach the international technology market.

22. Economic and technical infrastructure are vital to the development of the capital goods industry. Efficient and economical means of transport, communications, water and energy delivery are all important. Basic technical services such as casting, forging, heat treatment, manufacturing of jigs and fixtures, etc. constitute the technical infrastructure required to develop even the simplest capital goods industry. Although there are some techniques to reduce the dependence on, for example, casting and forging by using techniques such as cut-and-weld, they are limited and, therefore, the establishment of basic technical services should be given the highest priority. Furthermore, creation of local design and industrial engineering capacities should be considered at the earliest possible stage of the capital goods industry development.

23. Supply of raw materials and intermediate goods is another critical factor. In particular, availability of iron and steel products can be decisive in whether a capital goods industry can be sustained or not. In the case of simple capital goods steel constitutes the major portion of weight and, quite often, of cost. In many developing countries, there is a close correlation between the domestic production of iron and steel and the development of the capital goods industry.

24. The brief analysis of constraints given above was not made to draw a pessimistic picture. On the contrary, it was made to demonstrate that possibilities exist for developing countries to enter into the capital goods sector and to develop it provided that certain commitments are made and policies and strategies are followed.

25. The studies carried out for the First Consultation on the Capital Goods Industry and additional work done for this Second Consultation have clearly shown that the development of a capital goods industry requires complete dedication and demonstration of will on the part of the Government. Without relevant Government action based on clearly stated and concretely implemented political decisions, it would be difficult to establish a capital goods industry. This statement holds irrespective of the economic and political system of the developing country.

26. Economy-wide integrated planning which takes into account the linkages of the capital goods industry with other sectors is necessary. Since the demand for capital goods is determined at two levels, namely, that of the final users which involves almost all sectors of the economy, and that of the capital goods industry itself, planning cannot be limited to the capital goods sector only.

27. The planning of a capital goods industry in a developing country should give thought, among others, to the following:

- Overall development strategies for the capital goods industry, taking into account the linkages of it with the other sectors of economy;
- The selection of routes of entry (taking into account both the realities of the country and the socio-economic and political targets);
- Policies and strategies to remove the specific constraints to the selected development route;
- The transfer and progressive mastery of technologies and creation and growth in complexity of technological infrastructure;
- Strategies with regard to factors of international interdependence.

28. UNIDO has been developing a methodology for capital goods development planning along the lines described above. Aspects of this methodology have been tested successfully and are available upon request.

29. National planning alone is not enough to create a positive attitude towards capital goods manufacturing and to trigger the flow of international co-operation; design of viable projects is also necessary. Although

long-term planning should have a corollary such as long-term co-operation, experience reveals that the majority of co-operation arrangements are made for specific projects. The identification of types of capital goods to be manufactured and selection of their production routes are prerequisite activities for project designs.

30. The selection of capital goods for production by individual developing countries necessitates an iterative matching process between a set of capital goods grouped according to the technological complexity of their manufacture, and the socio-economic and political targets of the developing country. The matching process can be generalized by using characteristics of typological groupings of developing countries instead of those of individual countries.

31. Classification of capital goods can be made using the Analysis of Technological Complexity (ATC) method. ATC which has been developed by UNIDO since 1979 provides a suitable tool to divide the universe of capital goods into six groups according to a technological complexity index. This complexity index is calculated by taking into account the complexity level of all soft- and hardware activities involved in the manufacture of each capital good.

32. Technological complexity levels I and II involve, for example, simple hand tools and utensils, simple agricultural machinery (including irrigation and rural equipment), simple food processing equipment, simple new and renewable energy equipment, simple metal structures for buildings, simple construction and public works equipment, etc. Level VI, on the other hand, involves very complex equipment such as aircraft jet engines, gas turbines, etc. It should be noted that complexity level is dependent upon the selected technological route, i.e., the index can be reduced by simplifying the product design and/or manufacturing processes, or increased by complicating these parameters.

33. A typology of developing countries may be developed by using a set of macroeconomic, demographic, etc. indicators. Consequently, an almost infinite number of typologies is possible. Here, a very simple typology is adopted:

a) First, all developing countries are divided into three broad groups utilizing indicators such as capital goods production and imports, manufacturing value added in industry, etc.:

Group A - Newly industrializing countries (NICs) with a fairly well developed capital goods industry (7 countries). They accounted for almost 74% of the developing countries production of capital goods in 1981;

Group B Countries which have started to establish their industrial base with some capital goods industries and technological capabilities (approx. 30 countries);

Group C Countries with no or only an embryonic capital goods industry (more than 80 countries).

b) Secondly, Group C is further analyzed with the aim of regrouping the countries according to their major economic activities. For this purpose, indicators such as shares of agriculture and industry in GDP, exports and imports by commodity, etc. are utilized. This exercise is intended to identify the priority sectors and their capital goods needs. The analysis here is limited to Group C since the entry issue applies only to this group.

34. The preceeding analysis has shown that, with few exceptions, all Group C countries have targeted at meeting the basic needs of their populations. In terms of capital goods, therefore, agricultural machinery, rural equipment (including simple irrigation, transport and energy-related equipment), food processing machinery and construction and public works equipment are the priority items. It should be noted, however, that in some cases, the relative abundance of natural resources tends to shift the emphasis from agriculture to mining and processing. This shift may change the types of priority capital goods.

35. The above analysis, although very simple and over-generalized, gives an indication of the entry route in terms of products. Additionally, creation of repair and maintenance facilities should be added to the list of initial activities of the sector. In some cases, these facilities can form the nucleus of manufacturing and on-the-job training of industrial manpower. The next and most difficult stage, is to select the technological route or, in other words, to find an answer to the question "How to produce?".

36. It is difficult or even impossible for those developing countries which are entering into the capital goods sector to adopt the same products and production routes as the industrialized countries. The prevailing factors in developed countries such as complexity of product designs, critical size of production units necessary to ensure the required rate of technological innovation, etc. obstruct the creation of capital goods industries in the developing countries.

37. It is, therefore, necessary that another structural formula should be found which can dynamize and proliferate the activity of capital goods industries in developing countries. One solution is the multipurpose production route. Multipurpose production units have the purpose of replacing the production runs and production volume characteristics of specialized units, which are almost always incompatible with the markets of the developing countries, by manufacturing in small batches of a limited variety of products.

38. The multipurpose units must be designed and operated according to precise rules if their advantages are to be maximized. In particular, their operation should permit the accumulation of technological know-how. In this regard, it would be wrong to associate multipurpose production with random production which can be described as assuming that it is sufficient to have a certain stock of general purpose machine tools so varied that they can do almost anything. In multipurpose production, the various products manufactured must have some common dominant characteristics, in which context the nature of the production equipment is not the sole factor to be taken into consideration.

39. It can always be argued that some form of multipurpose production already exists in many developing countries. However, experience has shown that most of the examples of multipurpose production units in the developing countries were originally created as specialized facilities and had to be diversified under the pressure of declining markets. This process which might be called a compulsory diversification is different from the multipurpose concept discussed here. The multipurpose production approach is defined here as a carefully planned and implemented entry path into the capital goods industry. Furthermore, it permits the creation of manufacturing facilities which cannot exist if only the specialized units are considered.

40. Multipurpose production should not be planned and implemented as a "passive" entry into the capital goods sector. The multipurpose plant should be considered as a development pole which, in time, hands the manufacture of products over to new specialized units. The increase of the market and the mastery of the technologies within the multipurpose unit form the basis for this possibility.

41. The multipurpose production route brings with it some specific problems. At the project level, the selection of a homogeneous product mix and of compatible production technologies are very important. In this respect, UNIDO's experience has shown that creation of specialized project identification and design teams, and utilization of Analysis of Technological Complexity (ATC) methodology could be very effective.

42. International co-operation is indispensible to the developing countries efforts to enter into the capital goods sector. In this respect, the attitudes of the involved parties towards co-operation and their strategies, to a great extent, determine the success of development. Recalling the long-term nature of the development process of the sector, it is desirable that the co-operation arrangements should cover comparable time periods. However, this is not always the case.

43. Creation of an industrial planning system is the first activity requiring technical assistance. It should be stressed that planning is not a one-time activity; on the contrary, it is a dynamic on-going process. Therefore, a technical assistance programme should not be limited to the period required to draft the plan, but should extend into the implementation stage. In this regard, UNIDO has wide experience and has developed new and effective tools and methodologies for sectoral planning.

44. Diagnosing the existing facilities, and selecting the products and technological routes and carrying out feasibility studies are already project level activities which should be carried out within the framework set by the plan. UNIDO has gained experience in these areas and is in a position to provide technical assistance when requested.

45. Co-operation for project implementation involves, among others, transfer of technology (including training) and financing. Required technologies for transfer can range from adopted designs and manufacturing process files of simple products to those involving complex designs and processes, and large-scale training programmes. In some cases, small and medium-scale enterprises in developing countries may find it difficult to have access to the international technology market. The size of their operations may not be of interest to large-scale technology sellers in the developed countries. Additionally, small- and medium-sized enterprises from developed countries have, up to now, shown a cautious interest in co-operation arrangements involving technology transfer.

46. At the low-technology end, where the adopted designs are of importance, more developed developing countries appear to be the most suitable suppliers of technology.

Points for discussion

47. Technological change is accelerating rapidly and, of all new technologies, informatics can be expected to have most impact on the manufacturing sector. The informatics sector has been targeted by many developed countries, as well as some developing ones, as a priority for national efforts.

48. These new technological developments are affecting the industrial strategies available to the developing countries. The levels of technological complexity in the production of capital goods is increasing and, the entry to new stages of production is becoming more difficult for most of the developing countries. Therefore, the technological gap between industrialized and developing countries in the production of capital goods is widening.

49. The effects of such technological changes, give grounds for concern with regard to appropriate responses on the part of developing countries. New forms of production in developed countries which minimise the use of expensive labour, both skilled and unskilled, can affect developing countries' present advantages in terms of lower labour costs. Again, highly flexible production systems in developed countries may allow quick and improved responses to changes in demand patterns and material inputs prices, thus increasing their international competitiveness. National choices have to be made in full consciousness of international developments, and an explicit view of the country's international exchanges in the future. The following questions therefore arise:

a) What are the implications for the future international division of labour; in particular, will the present gradual process of redeployment to the developing countries be arrested or reversed?

b) To what extent should national choices in the manufacture of capital goods in developing countries be influenced by the above?

c) Is it in the long-run interest of developing countries to enter into the capital goods sector by adopting low level technologies, bearing in mind the accelerating pace of technological change?

d) What new measures of international co-operation can best assist developing countries in making these choices and carrying them out, and how can UNIDO contribute to this end?

50. As already emphasized in this paper, the most difficult stage for a newcomer developing country is that of entry into the capital goods sector. The following questions therefore arise:

a) What criteria should be used in determining:

- Sub-sectors of capital goods production;
- Specific products; and
- Technological routes of entry?

b) What role can regional co-operation play in promoting the entry of developing countries into the capital goods sector?

c) What could be the validity of the multipurpose production approach as an entry route?

d) What forms of international industrial co-operation could be used to support the multipurpose production approach?

e) How could UNIDO increase the effectiveness of its technical assistance in the field of capital goods industry, and particularly in the development planning of the sector utilizing, among others, the Analysis of Technological Complexity (ATC) methodology, to those developing countries which are entering into or broadening their capital goods industries?

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Issue Paper II

DEVELOPMENT OF ELECTRIC POWER EQUIPMENT SECTOR AND TECHNOLOGY UNPACKAGING *

Prepared by the

UNIDO secretariat

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1. Electrical energy is one of the most important contributors to the industrialization and overall growth of a developing country. All developing countries, therefore, have given high priority to electrification in their economic and social policies and, as a result, the electric power sector has been growing fast in these countries.

2. Investment in the electric power sector is very capital-intensive. Electrification programmes claim one of the largest shares of public investment in most developing countries. Very large investment costs in general, and high foreign currency requirements in particular constitute a major constraint and, at the same time, increase the importance of the role played by multilateral financing organizations.

3. The development and operation of an electric power system involve all the hard- and software activities related to the generation, transmission and distribution of electrical energy. Hardware activities such as manufacture, assembly and repair and maintenance of all related equipment, construction of structures and buildings, and software services such as planning, feasibility studies, consultancy and engineering, contracting, supervision, operation and management and research and development cover a wide spectrum of varying complexity levels. This wide scope which varies from a simple wooden distribution pole to the very complex gas turbine; and from simple civil engineering for rural electrification to very complex large power plant engineering, makes it possible for developing countries to enter into the electric power sector at a complexity level which is compatible with their development stage.

4. In order to be able to fully describe the process of development of the electric power sector, one must take into consideration all the activities mentioned above. This approach, compared with that which focusses on the electric power plant equipment only, makes it possible not to limit targets merely to the production of capital goods, and consequently, not to exclude a large number of developing countries from the scope of discussion. In practice, furthermore, equipment in the strict sense represents on the average only 50% of investments (for a medium voltage distribution line, for example, the share of equipment is even lower).

5. At the world level, the heavy electric power equipment industry is often represented as an oligopoly, or cartel. This statement can be softened in the case of less complex equipment, for which the technology has been mastered in a large number of small- and medium-sized companies in the industrialized countries and in a growing number of developing countries.

6. The following is a brief diagnosis of the present situation in the electric power equipment sector:

a) Worldwide:

- Since 1980, world trade of electric power equipment has been shrinking due to reduced demand in developed countries and financing difficulties faced by developing countries;

- In most developed countries, the domestic market is highly protected. Reduced domestic market, therefore, forces the firms to promote their exports to developing countries;

- The relative importance of the electric power equipment market in the developing countries, which consists of approximately US$ 15 billion per year of imports, mostly from the industrialized countries, has greatly increased by the current decline in the world market;

- The present state of the world market should permit closer commercial and technical co-operation between developed and developing countries.

b) In industrialized countries:

- There is a significant unutilized capacity;

- The concentration of the electric power equipment industry is increasing with an ever decreasing number of firms in manufacturing;

- Overhead costs in general, and R+D costs in particular are soaring;

- As a response to the changing market conditions, not only the Transnational Corporations (TNCs) but also the Small- and Medium-sized Enterprises (SMEs) from developed countries are changing their attitudes toward transfer of technology to the developing countries.

c) In developing countries:

- The production of electric power equipment is concentrated in the Newly Industrializing Countries (NICs);

- The capacity utilization of the existing manufacturing facilities is very low;

- For the less complex equipment there can be room in the world market for manufacturers from the NICs.

7. It is interesting to note that, in most developing countries, the new capacities have been created through turn-key supply arrangements. These arrangements which have a negative impact on the development of an indigenous industry have possibly been made as a result of:

- Policies of packaging of large power generation and transmission projects of high technological complexity, effectively excluding local participation;
- Policies of funding agencies that would actively prejudice against all but established firms;
- De facto actions on the part of, for instance, electric power utility decision makers in the developing countries who may believe that for the reasons of product quality, reliability or consistency or simply from habit that equipment must be purchased from a foreign supplier.

8. In order to reduce the payments in foreign exchange and to increase their self-reliance, the developing countries have to step up their efforts for domestic manufacturing of electric power equipment in whatever modest a way possible. Electricity is an essential component for industrialization. However, the priority for manufacturing electric equipment would depend on the extent of electricity required, patterns of industrialization, priorities of other sectors which may claim skilled personnel and financial resources, etc.

9. The electric power equipment industry is not a prime-mover of and/or an entry route into the capital goods sector. On the contrary, its development depends upon the existing level of the capital goods industry, engineering skills and supply of intermediate goods. For all countries, therefore, there is the question of linkage between the electric power equipment sector and the capital goods sector as a whole.

10. Planning is crucial to the development of the electric power equipment industry. Planning here should be considered in the broader context of integrated energy/industry planning and in particular in the context of the planning of the capital goods industry development.

11. Integrated energy/industry planning involves, on the one hand, estimates of the type and amount of energy needed to achieve the social and economic targets and, on the other hand, identification of industrial inputs required

for energy development. Although the development of electric power system should be considered within the framework of integrated energy/industry plans, policies and strategies for the development of the electric power equipment industry should be based on the sectoral development plan of the capital goods industry.

12. Planning of the electric power sector and implementation of plans are relatively easy when the central role of the State in the sector in developing countries is considered. Almost without exception, the government owned electric utility company is in charge of the development and operation of the power system in developing countries. The purchasing power of the utility company, therefore, is determinant of the indigenization of development and operation of the electric power system.

13. All the hard- and software activities involved in the establishment and operation of electric power systems are defined here as the "technology package". Indigenization of this package is only possible when the contents of the package are progressively mastered. This is by no means an easy task: Constraints such as lack of policies and strategies, market size, technological complexity of equipment, investment costs, financing, lack of negotiation skills, training, standardization, etc. hinder the development and indigenization of the electric power system.

14. To overcome some of the above-mentioned obstacles, various strategies can be followed. One of the favoured approaches is "technology unpackaging". Technology unpackaging is defined here as the capability of breaking down a power system project into its component activities and progressive mastery and/or indigenization of each activity.

15. The main aim of technology unpackaging is to avoid turn-key operations which generally exclude domestic participation. Different unpackaging policies and strategies can be followed to achieve this goal. The policy framework and strategies are dependent not only on the stage of development of individual countries but also on the political choices.

16. The information on individual countries have indicated that irrespective of the differences in approaches to technology unpackaging, the State has

played a central role in every country. Integrated energy/industry planning, formulation and implementation of policies and strategies, and utilization of purchasing power through public utilities emerge as some of the areas in which the State should play an active role.

17. In each country case study carried out for UNIDO, it was clearly indicated that the first step toward technology unpackaging has been the establishment of national engineering and consultancy services. Manpower training, therefore, appears to be the most urgent issue to be dealt with if rapid mastery of technologies is desired.

18. Technology unpackaging, as defined here, involves all activities related to electric power system development. It is, therefore, necessary that unpackaging policies and strategies should also focus on, among others, civil engineering, construction, assembly and repair and maintenance. These activities are generally within the capabilities of many developing countries and constitute a large portion of the total investment.

19. Policies and strategies for the manufacture of electric power equipment, however, should be considered within the capital goods sector as a whole. This requirement is another reason why integrated energy/industry planning in general, and capital goods sectoral planning in particular is very important.

20. The development of an electric power equipment sector together with the software services is a long-term undertaking. The long-term development patterns depend upon the typological characteristics of individual countries and the adopted policies and strategies. Different routes have successfully been tried in different countries. Each route has its own costs and critical success factors. Furthermore, the rate and speed of indigenization could be different in each route.

21. Almost all developing countries give very high priority to rural electrification. It is also true that in many developing countries there is scope for local industries and skills to participate in rural electrification programmes. In particular, the experience with the micro- and mini-hydroelectric projects has already proven this point.

22. It is clear that the development of the capital goods industry in general, and electric power equipment sector in particular calls for, first and foremost, a considerable effort on the part of developing countries themselves. Through such an effort they can build a human potential and an industrial base that enable them to negotiate with the owners of technology and increase their participation in the projects.

23. Technology ownership and manufacturing in the electric power equipment sector is highly concentrated in the developed countries and in a few NICs. International co-operation, therefore, is indispensible if it is desired to develop this sector in the developing countries. Some of the possible areas for co-operation between the industrialized and developing countries and among developing countries themselves are discussed below.

24. Development of the national engineering capacity should be the first activity toward unpackaging. One of the most effective training methods for the technical personnel required by local consultancy and engineering services is to get them involved in the project design studies which are normally carried out in the design office of the supplier. Furthermore, co-operation with independent consultancy and engineering companies from developed countries can help to master the techniques utilized to prepare the feasibility studies, project design, contract negotiation and bid evaluation, project supervision, etc.

25. Surveys of existing hard- and software capabilities in the developing countries and integrating them in the electric power system projects is one of the most important steps toward indigenization. Such surveys could also help to identify the new industrial activities to be promoted. Technological know-how and subcontracting experience are prerequisites to the success of such surveys. At the beginning of the technology unpackaging and indigenization process, the domestic utility company and/or national prime contractor would generally lack the know-how and experience and, therefore, needs the technical assistance of the technology owner and/or manufacturer. Co-operation in this area also provides excellent training opportunities for local engineering personnel and planners.

26. The efficient and uninterrupted operation of the electric power system is dependent mainly on two factors: Proper repair and maintenance of the installations and correct management of operation of the system. Repair and maintenance of generation, transmission and distribution subsystems is a complicated undertaking and, in the long run, could establish the nucleus of manufacturing activities.

27. Training for repair and maintenance should start very early in the system development, preferably during the manufacturing and assembly of equipment. This requirement necessitates the training of personnel at the manufacturer's plant and their full participation in the assembly activities. It is necessary to secure such training programmes and participation in the assembly while negotiating the power system contracts. It should also be remembered that manpower training along the lines mentioned above is indispensible not only for repair and maintenance but also for manufacturing activities to be pursued later.

28. It is interesting to note that the electric power sector calls for a high degree of regional co-operation. Yet, the examples of such co-operation among developing countries are not many. Interconnection of national electricity networks between neighbouring countries could generally be taken as the first step towards regional co-operation. Interconnection, first of all, makes it possible the better utilization of installed generation capacities and easier handling of peak power demands. Secondly, it promotes regional co-operation through which the markets could be expanded to reach economic scales for manufacturing. This puts the neighbouring countries in a stronger negotiating position vis-à-vis the technology owners.

29. One of the main technical barriers hindering regional co-operation is incompatible standards. Standardization, therefore, emerges as the first issue to be dealt with. Every effort should be spent to formulate common standards and to eliminate non-technical and/or commercial reasons for adopting different standards by individual countries of the region.

30. Even without interconnections and/or joint manufacturing projects, it is extremely important that the developing countries exchange technical and

commercial information on their electric power systems. Technology unpackaging in general, and project design, contract negotiation, prices, operation and management in particular, are important areas for information exchange.

31. Joint electric power equipment manufacturing projects between developing countries are another form of co-operation. The parties in such projects may own no technology themselves; in these cases joint technology transfers are necessary. In some other cases, however, one of the parties may have already transferred and/or developed the technology; then the project implementation could be similar to those implemented by a firm from an industrialized country.

32. One of the barriers to co-operation between developing countries is the insufficient institutional framework to promote such co-operation. For this purpose, much work has to be done at regional and international levels. Close co-operation between international organizations concerned with the subject is also needed.

33. An interesting area requiring further investigation is the manufacture of equipment for new and renewable sources of energy (NRSE). In particular, there is scope for international co-operation in the development of small-scale hydro-power. UNIDO's experience has already demonstrated that many developing countries have the basic mechanical production capabilities to participate in mini-hydro projects. In this area, co-operation possibilities between developed and developing countries and among developing countries themselves should further be identified.

34. Manufacture of some other simple NRSE equipment such as bio-gas digesters, solar dryers, etc. offers excellent opportunity to develop rural capital goods industries. Manufacturing of such items could easily be integrated into the larger volume production of simple agricultural machinery, simple food processing equipment, etc.

Points for discussion

35. It is possible to define a progression of goods and services in the electric power sector from the least to the most complex. As developing countries advance in their capabilities they add new and more complex products to the product mix. There is, therefore, a progression along the development line and by and large there is no evidence of a country leap-frogging from a lower manufacturing group to higher levels. Moreover, policies of packaging larger power generation and transmission projects may effectively exclude local participation. Policies by funding agencies or utility decision-makers may also be biased against local production. Policy-makers and funding agencies can, therefore, play an important role in overcoming such a bias against local production of electric power equipment.

36. Considering the importance of energy, and in particular electricity in the industrialization process, the following questions arise:

a) How could two clearly different but closely interlinked concepts, namely, development of electric power system, i.e., electrification, and manufacture of electric power equipment, be integrated within energy/industry and capital goods industry planning?

b) How could the international community assist the developing countries to develop a methodology for integrated energy/industry planning in general, and the capital goods sector and the electric power equipment industry planning in particular?

37 In relation to entry into more advanced stages of production of electric power equipment, the following questions arise:

a) Under which conditions can a developing country enter into the next stage of production of electric power equipment?

b) What would be the main strategical guidelines to establish and develop a national engineering capacity and promote domestic participation in electric power system projects? (Changing strategies applicable to different groups of countries.)

38. In relation to the technology unpackaging issues in the electric power and electric power equipment industries, what would be the relevance of the following in bringing transparency to the technology package and to its components:

a) - Disaggregated cost and complexity analysis of package components;

- Review of practical experiences of different developing countries and their enterprises in applying the unpackaging approach;

- Survey of the strategies of parties involved and infrastructural conditions which determine the success of implemeutation of the unpackaging approach;

- Analysis of critical operational problems faced by all parties involved in planning, designing and executing disaggregated electric power system investment projects;

- Investigation of institutional framework required to promote technology unpackaging in individual countries and foster co-operation between interested parties.

b) What are the most important elements to be considered in the formulation of a basic model for the unpackaging of technology in developing countries?

c) What would be the main strategical guidelines to establish and develop national engineering capacity and promote domestic participation in electric power system projects?

39. As far as the roles of the utilities in developing countries and bilateral and multilateral financing institutions are concerned, the following questions arise:

a) How could the purchasing power of public utilities be used to strengthen the negotiating position of developing countries especially regarding unpackaging of technology and, at the same time, to promote domestic industries?

b) Financing for most of the large electric power projects in developing countries is arranged by bilateral and/or multilateral financing institutions: What are the possibilities of adopting policies by these institutions in order to permit or promote the national participation of developing countries in the implementation of electric power projects?

40. In relation to the co-operation possibilities which exist between developing countries, the following questions arise:

a) What would be the benefits of and possibilities for regional and interregional co-operation among developing countries involving exchange of technical and commercial information, network interconnections, and finally, joint projects?

b) What would be the barriers to co-operation between developing countries in this sector and how could the international community contribute to promote such co-operation?

41. Considering the importance given by many developing countries to rural development in general, and rural electrification in particular, the following questions arise:

a) What could be the impact of electrification on rural development and what are the centralized and decentralized alternatives for rural electrification with possible maximum national participation?

b) What would be the preferred institutional framework to optimize the efforts of all involved parties in the small-scale hydropower development?

c) How could the rural and other small-scale capital goods manufacturing units be also involved in the production of simple energy-related capital goods?